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ABSTRACT

An operational definition of computer literacy for higher education is offered after reviewing various views concerning literacy and computer literacy. Some writers have specified levels of expertise beyond that of nonuser, ranging between the casual end-user and the programmer. Other definitions emphasize the computer as a tool and the importance of understanding some of the machine's capabilities. Objectives for two types of literacy programs are compared: an awareness program and a rigorous course that includes programming. Attention is also directed to results of a survey of adult attitudes toward computers, workplace-sponsored programs to train staff to use computers, literacy with personal computers, computing courses for adults, computer literacy at college, literacy for faculty, and computer-supported learning. It is concluded that computer literacy seems to have three components: the ability to use a computer as a tool, the ability to manipulate a computer beyond that of the casual end-user, and enough knowledge of the computer's capabilities to make intelligent decisions regarding its social and political use. The ability to manipulate a computer can be acquired either by learning to use an applications package or actually learning to program. (SW)

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(1983)

DEFINING COMPUTER LITERACY

FOR HIGHER AND ADULT EDUCATION

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In the five years since microcomputers were first used in schools, the subject of computer literacy for elementary and high school students has received considerable attention. Less notice has been given to their parents' need for computer literacy or to instructional computing at the college level. Although the literature on computer literacy in higher or adult education is not nearly as substantial as that for el/hi, there is some recent commentary on the subject, most of it available through ERIC and in periodicals directed at various segments of the education market. Some national magazines have run articles recently on personal computing and its implications for adults. Though limited in number, these articles are helpful in determining the average adult's current state of computer literateness. In their concern that their children not be unprepared for the computer age, adults may have--through apprehension or the press of other responsibilities--neglected their own need for twentieth-century literacy. But what is computer literacy, particularly for citizens old enough to vote, what is it good for, and how is it obtained? This paper considers these questions.

DEFINING COMPUTER LITERACY

Computers and Literacy

In the 30 years since the beginning of what is now commonly regarded as the third great revolution in communications, the computer has perhaps been involved in the symbolic representation of as many words as both preceding revolutions--written language and the printing press. It surely has caused more contemporary comment and controversy than writing or printing did. Further, the written word may be even more significant in the computer age as word processing and telecommunications produce ever more of them and make information passed in written form more essential to the conduct of daily life. The very words with which one programs--read, edit, print--are derived from preelectronic

communication, and the facility with which these commands produce words may cause greater reliance on, and perhaps higher standards of clarity for, written communication than now.

The computer, thus, is taking its place in the history of literacy, and when attempting to define this form of literacy, it is helpful to view it as one in a series of literacies. An attempt to do so, a recent article by Carolyn Mavin entitled "Computer-Ease: Twentieth Century Literacy Emergent," discusses computer literacy in the context of general literacy and works toward a definition of the term.[1*] Marvin considers how various literacies have been the property of an elite until it was deemed socially or politically useful for the skill to be spread amongst a greater portion of the general populace.

Marvin's article begins with an assertion that "the definition of literacy continues to trouble everyone with a serious interest in the topic" because

> Every measure of literacy ever devised appeals to some criterion of success in interpreting messages, and success in interpreting messages will always be a socially constructed rather than an objective category.[2]

Literacy, then, is an ability to decode whatever message systems a culture considers important. Literacy has, even in the relatively brief history of the United States, been defined in various ways. It was, during the Colonial period, an ability to recite the Lord's Prayer and certain Biblical passages. After the Revolution, it became some ability to read and write in one's native language. This soon was insufficient for a nation wanting to "purify itself of regionalisms" and to establish a "common standard of virtue and morality," from which impulse evolved our system of public education.[3] The free public school assimilated the immigrant and provided literacy in a common tongue sufficient to build an industrial democracy. In two hundred years, then, the definition

[1*] This article was written by Marvin and Mark Winthur. As she has written on the subject before and is the main author of this one, only she will be referred to when discussing the article.

of literacy has evolved from reciting the Bible to being able to read a newspaper editorial or instructions from the Internal Revenue Service. Might this soon be redefined to mean an ability to interact in some way with a computer?

For a definition of computer literacy, Marvin electronically polled representatives of a "contemporary priesthood," highly trained and talented programmers, asking how they would define it. She received 60 responses from leading research labs, university-based computer centers, and computer manufacturers. In addition to the computer literacy question, Marvin asked respondents to provide metaphors for computers and power relationships with them, and to organize computer users into categories of competence.

Her respondents tended to describe the computer as a tool and, not surprisingly, compared it to tools associated with men. But almost a third of those surveyed used metaphors indicating that they regard the computer as an independent intelligence. One described the power relation as "I pull the strings, but it has a pair of scissors;" another as "I can usually get what I want, but sometimes I have to run around the block first." These comments—perhaps a partial explanation of the "independent intelligence"attitude -- indicate that highly proficient programmers have some notion of competing with the machine when trying to get it to do their bidding.

Marvin's survey arrived at four levels of expertise beyond that of nonusers, whom she notes actually use microprocessors frequently in their daily life without realizing it—in their cars, phones, watches, microwave ovens. The other levels are casual end-users (like airline reservation clerks), programmers (with a wide range of competence), hackers, and wizards. Most of her respondents identified themselves as falling somewhere between the last two categories. Going the other way, one respondent offered this categorization: "can design them, fix them, program them, can't program them."

Their definitions of computer literacy would assign the term to people

who fall somewhere between the casual end-user and the programmer. A quarter of Marvin's respondents "believe programming ability is the bottom line for computer literacy," about the same number "are willing to settle for some level of end-using skill," which Marvin refers to as the "hard" or "soft" criteria for computer literacy. She also reports a seemingly casual but highly useful definition, given by a computer scientist at Carnegie-Mellon:

> The minimum I would expect in computer literacy in a reasonably well educated person today ... is /knowing/ that computers are complex devices which when properly instructed can do almost anything: that the instructing currently requires very painstaking and meticulous work and may not always be correct: that anyone who says, "We can't do anything about that, the computer (followed by any asinine excuse)," should be told politely that the problems of the computer are something to be resolved by the staff on the company's time, and not on the victim's, and you will please straighten this out immediately without any further excuses.[4]

This definition brings up two more essential points about computer literacy: one, that it involves knowing what a computer can do and how complex a process this is, and two, that real people control computers. Many definitions of computer literacy aim at these points, but few manage to do so quite as graphically. One assumes that the person who offered this definition does not regard the computer as an independent intelligence, but rather as an extremely powerful tool. The ideas collected in Marvin's survey--that the computer is a tool, whether or not literacy requires an ability to program, and knowing something about the machine's capabilities--appear frequently in other definitions of computer literacy.

The Computer as Tool

Marvin's survey and article serve many valuable purposes, one of which is that the definition of computer literacy she is searching for is not specific to schools. Most other definitions are sought in a school context, and most often--because this is where most of the activity has been--for elementary and high school students. Another good discussion of the subject is provided by

David Moursund, computer scientist at the University of Oregon and editor of The Computing Teacher. In remarks made at a 1982 conference on computing and education, Moursund took up the theme of the conference--that the computer is an "extension of the human mind," a tool much like a spear or a saw, which are extensions of the human body.[5] His examination of computer literacy regards the computer as a tool with a specific function in the life of a student. Similarly, computer literacy for grown-ups can regard computers as tools, relevant to their tasks or purposes.

Reading, writing, and mathematics are other aids to the brain, extending one's capacity to absorb and retain information and to communicate with others. Modern mathematics is also a "mind tool," which after centuries of development has provided us with both a notational system and algorithms for the solution of computational problems, a capacity that the computer has vastly enhanced. It is interesting to view this enhancement in light of another of Moursund's comments:

> Today's eighth grader can solve computational problems that were beyond the capabilities of all but the most brilliant mathematicians of two thousand years ago.[6]

Computers are advancing capabilities of even greater proportions, and at a considerably faster pace.

Moursund mentions, as do many writing on the subject, that just as algorithms have reduced once complex mathematical questions to simple formulae, schools are questioning which skills should still be taught--should some, like spelling and long division, which with a computer can become unnecessary, still be part of the curriculum? The trained mathematician may learn to repeat the steps by which these algorithms were devised, but everyone using them need not be able to.

Moursund also says that computer literacy can be acquired at several different levels of expertise, all of which relate to the function one wants the

computer as tool to serve. Should we expect that today's students are most likely to use computers for computation and word processing, or will being able to access a database phone directory and library catalog suffice? And will this level of literacy be sufficient for science or other technical courses? As Moursund points out, computer-ease can be acquired at many different levels, and what is applicable for one application may not work for another. We need tools appropriate for the tasks we put them to, and to be able to use them at a level appropriate to our level of skill.

Is Programming Essential?

"Defining computer literacy is like aiming at a moving target," says Andrew Molnar of the National Science Foundation, which has funded many projects that have taught computing in one way or another.[7] Although there is considerable agreement that the computer is a tool and that literacy involves using it to accomplish one's purposes, there is much disagreement as to whether or not the ability to program is essential to this practical use.

In an article called "Everybody Wants 'Computer Literacy,' So Maybe We Should Know What It Means," published by the American School Board Journal, Dan Levin, one of its editors, says that learning to program "depends primarily on what you expect your students to be able to accomplish by being computer literate."[8] Expanding on this idea, Levin quotes a director of an Office of Education funded project attempting to define computer literacy: it is "discipline dependent." He sums up her comments as, "Being computer literate, then, ... would not be a matter of mastering a given body of knowledge, but of mastering knowledge and skills sufficient to use computers effectively in your work."[9]

This definition of computer literacy would probably not include an ability to program. If computer literacy is like general literacy, then programming may be essential--would we call someone literate today who knows who to read but

cannot write? In some ways, the development of computer literacy is moving in an opposite direction than general literacy. Where once an ability to form the letters of the alphabet may have been sufficient for literacy, now it demands, among other things, the ability to fill out a job or mortgage application. Programming, on the other hand, has become an increasingly less complex skill, with menu-driven applications packages available for most all uses and the BASIC language available for others most users are likely to encounter.

Arthur Luehrmann and Alfred Bork, two nationally known and widely sought after commentators on the subject of computer literacy, contend that programming is essential to literacy, but disagree strongly on the widespread use of BASIC to accomplish this purpose. Luehrmann was among the computer enthusiasts at Dartmouth, where BASIC was devised, who founded one of the country's first instructional computing programs. He advocates the use of BASIC, although he is surely aware of its limitations, since its virtue is its ease of use. Credited by his publishers as having originated the term computer literacy, Luehrmann has also just published a text by that title, which is a course in BASIC used by both high school students and their teachers.[10]

Bork vociferously opposes the use of BASIC, calling it "the junk food of modern programming,"[11] because it teaches bad programming habits. In a paper presented at the conference on the computer as an extension of the human mind, Bork quoted Edsger Dijkstra, a distinguished computer scientist, to augment his comment:

> It is practically impossible to teach good programming to students that have a prior exposure to BASIC: as potential programmers they are mentally mutilated beyond hope of regeneration.[12]

Bork, who is visionary in most of his discussions about computers and education, may be losing this one, as BASIC is the language built into almost all microcomputers and the only one available with many. The argument, too, may become moot as menu-driven programs are ever more available for most of the things people do with computers.

The chief argument for learning to program may not be that it provides the user with some degree of control over a computer, as Luehrmann and Bork both seem to contend, but that it teaches habits of mind that to people trained as physicists--which Bork and Luehrmann were--would be desirable to spread more liberally amongst the populace.

To consider the necessity of programming, two types of literacy programs will be compared. Both are described by Levin in "Everybody Wants Computer Literacy." One is an awareness program; the other a more rigorous course that includes programming. The learning objectives for the awareness program, which is as applicable to grown-ups as to school children, are:

1. What a computer can and cannot do
2. How computers work
3. How to use a computer
4. The various roles of computers in our society
5. The impact of computers on our society[13]

Useful though these objectives may aim to be, there are many levels at which one can meet them--there is, for instance, a vast difference in knowledge between an eighth grader who has written a few brief programs in BASIC and a computer scientist who has helped design an operating system, but both require some understanding of "how computers work."

The literacy objectives devised by the Minnesota Educational Computing Consortium (MECC), a group that has led the way in establishing statewide computer education programs, are more specific and in their execution considerably more rigorous. The MECC guidelines, which have served as a model for other programs, identify 67 objectives grouped under six headings:

1. Hardware
2. Programming and algorithms
3. Software and data processing
4. Applications
5. Impact
6. Attitudes, values, and motivation[14]

Under programming and algorithms, according to Levin:

> Students must be able to explain what a simple algorithm accomplishes, modify an algorithm to accomplish a new but related task, detect and correct errors, and develop an algorithm to solve a specific problem.[15]

This is a rather demanding requirement, particularly to someone for whom algorithm is a new word, which is true of many of the adults now learning to cope with computers.

The difference between these two programs is the difference, for instance, between taking a course on mathematics in our culture rather than learning at least some calculus. There is virtue in requiring that to be liberally educated one must have some notion of the latter, but it is useful more in the concomitant thinking processes it teaches than in its practical usefulness in the lives of most adults.

Levin also cites Daniel Watt, LOGO proponent and popular writer on computers and education, whose definition of computer literacy requires programming. His definition seems possibly more applicable to parents than to their children. It is, as Levin gives it:

> --The ability to control a program and a computer to achieve a variety of personal, academic, and professional goals.
> --The ability to use a variety of preprogrammed computer applications in personal, academic, and professional contexts.
> --The ability to understand the growing economic, social, and psychological impact of computers on individuals, on groups within our society, and on society as a whole.
> --The ability to apply computer skills to information retrieval, communication, and problem solving.[16]

However, for those intimidated by such heady requirements, Watt offers an elaboration on his definition:

> Education for computer literacy, as I have defined it, should be thought of as more like the lifelong process of acquiring a culture than like the mastery of a well-defined body of subject matter.[17]

Possibly inherent in Watt's definition, as well as in those of other "hard-siders" is learning enough about a computer to be able to construct a mental model of what is going on inside the machine--even though many of these

operations have no visible component. Watt's reference to "acquiring a culture" and that this is a "lifelong process" are particularly appropriate for an adult model of computer literacy.

COMPUTER LITERACY FOR GROWN-UPS

Workplace-Sponsored Programs

Some businesses and educational institutions have recognized that adults need to become computer literate as much as children do, and are establishing programs to meet this need. Many adults have not only to learn something new, as they will in order to become comfortable with a computer, but have a resistance to dealing with computers that must first be overcome. Business Week reported on a survey conducted by Booz, Allen, Hamilton which considered adult attitudes toward computers.[18] According to the study, one-third of all "knowledge workers," which is how the study characterized professionals and executives, are "wary rather than receptive" toward the machine. And 10 percent of these people, Booz, Allen estimates, will be cyberphobes, people with an irrational fear of the computer.

The study provides some characteristics of people likely to be afflicted with one category or another of cyber fear--and interestingly enough, it asserts that age and children provide a breaking point between receptivity and wariness. Executives over 40 tend to be more intimidated, in part because their children often know more about computers than they do, and they fear appearing stupid. Those under 40 either do not have children old enough to be computer whizzes, or perhaps as children of the 1960s, are less likely to be threatened by something their children know and they do not.

Other interesting findings from the Booz, Allen study are that level of education affects receptivity to computers less than whether or not one learned to type, and that people who are dissatisfied with how they use their time are more likely to be receptive than others.

The Business Week article ends with the comment that one cannot learn to use a computer in the abstract; one must rather pick a real business problem and solve it with a computer. One company that is trying a variation of this approach is United Technologies, the corporate umbrella over Carrier air conditioners, Otis elevators, and Sikorsky helicopters. It has started an executive education program for managers making over $50,000 per year, three days of intensive training with an IBM PC, at the end of which the executive is given the PC to use in whatever manner he wishes.

According to the May 1983 Time magazine report on this project, United Technologies is "the first giant U.S. industrial corporation to attempt so broad an experiment with personal computers."[19] Its approach seems to be: give an executive enough training with a computer so he can find a problem the computer can solve. Thus far, this approach has taken with about 20 percent of the executives who have been through the course--these people report using the PC daily. Others turn to it occasionally, and few report not wanting to use it at all. A comptroller, who even after the training felt far from mastery, took his home for three weeks of "making his mistakes in private." Now he estimates that his productivity has increased by 10 percent.

Cuyahoga Community College outside Cleveland instituted a similar program in the fall of 1981, although on a considerably less expensive scale but with possibly more successful results.[20] Rather than giving away $5000 PCs, Cuyahoga loaned administrators Atari 400s, which then sold for around $200 apiece. Users were to attach the Atari keyboard to their TVs at home and by modem to the school's mainframe. This arrangement lasted for a 10-week quarter, during which the administrators--15 at a time go through the course--also attended a two-hour seminar each week.

The response was overwhelmingly positive--the administrators' attitude went from "indifference to enthusiasm, from anxiety to frustration"--they all

wanted their own computer to keep. The computer center staff which sponsored the literacy seminar was also pleased because the administrators who have been through the course were more knowledgeable and cooperative with its staff. Also, the administrators began to make better use of electronic mail, word processing, and the on-line student information system.

The course was organized around presenting material during the weekly seminar and practice at home during the evenings. The staff quckly discovered that "the most formidable task" for these administrators was getting logged on, and that this had formerly been the greatest barrier to greater use of the college's computer. For help, a phone number was provided for evening hours. The course also covered electronic mail, accessing college databases, word processing, financial planning, and a spreadsheet program.

Personal Computer Literacy

Thus, proficiency with a computer is acquired by using a computer to solve a problem that would need attending to, with or without the computer. But one must acquire a certain amount of proficiency before one can attack the problem one wants to solve. There are two ways to do this, one requiring programming and one not. Advice on purchasing a microcomputer increasingly includes the admonition that you have to first figure out what you want a computer to do, which usually means what kind of software you want to run, and then buying a computer that will do it. If appropriate software is not available, or after having gone beyond available applications programs, it may be necessary to learn to program in order to describe to the computer the problem it is to solve.

Two college professors, one with a technical background and the other without one, described this process at a 1982 conference on adult education.[21] One, the less technical, had recently purchased an Apple and started with a word processing package, then later acquired home management and educational packages

for his children. His colleague, who had owned an Apple for some time, is primarily a hobbyist and reported learning machine language in order to understand the computer's operating system. Both had learned enough about their computers to get them to do what they wanted, and one actually programs while the other does not. Both found their facility not only enabled them to be much more productive in dealing with paperwork (particularly the applications-oriented user), but that the computer also led to more orderly and organized thinking and sharpened memory capacity. They also like the intellectual stimulation of mastering a new skill and the feeling of "being in touch with the future."

Both also saw, in the process, implications for adult education. The challenge faced by adult educators they say is finding more ways of "enhancing interaction and self-directed involvement." They also felt the need for more software, particularly that with a "humanist" orientation, in which the learner assumes responsibility for his learning. What is available, they felt, is "behaviorist" software, in which the learner is responding to external goals.

Recently devised computer courses for adults may be about to start meeting this need. In Chicago, a research and development center for computer graphics sponsors a course in Z-Grass, a special language that enables the novice programmers to learn to create graphic images via computer--and perhaps to do more interesting artwork with a computer than they had done with a paintbox. New York magazine recently described two graphics courses being offered there to people whose interest exceeds their technical competence.[22]

Computer graphics, with its extraordinary potential for both practical and aesthetic purposes, may be, with sound, the adult equivalent of computer games. The intellectually curious grown-up who wants to do something with a computer, yet who feels no need for word processing or financial planning applications, may find this form of expression not only fascinating of itself, but a way in which to acquire some computer literacy.

To satisfy the needs of those with more mundane interests, there has recently been a proliferation of computing courses for grown-ups. Offered by computer stores, in manufacturers' retail outlets, and by proprietary computer learning centers--as well as by colleges--these courses offer literacy prior to purchase and training in applications packages after one gets the computer home.

These courses tend to appeal to more practical needs--word processing is by far the most popular, followed by financial planning and file management applications. Courses that offer merely first lessons in literacy are also popular, particularly those offered by colleges, which tend to be less expensive than those given by profit-making stores. One such course, offered by a community college, drew so many people that the school paid for its investment in Commodore 64s in one term.

Supplying adults' need for competence with computers could provide colleges willing to respond to it quickly with tuition income they need with college-age students declining in number. Recent conferences on the challenge of rapidly developing telecommunications technology have focused on this issue.[23] Some innovative programs are underway--providing career education to students in isolated areas through an electronic extension service, courses via interactive TV beamed to rural libraries and industrial sites--provide useful examples. Capitalizing on adult interest in computer graphics and music could become popular continuing education courses if offered by schools with strong programs in either area. General interest in science and technology may increase as mid-life adults feel pressed to develop opinions on such issues as nuclear energy and genetic engineering, subjects for which their undergraduate educations, acquired in a period of lenient requirements in science, may have left them unprepared. Computer-assisted instruction, which has not been notably successful in the remedial college courses in which it has been tried, may work better with adults who want to quickly acquire some notion of a subject and may put up with

a computer in order to do so, particularly if they can manage to acquire some competence with a computer at the same time.

COMPUTERS IN HIGHER EDUCATION

Computer Literacy at College

The May/June 1982 issue of the Forum for Liberal Education, published by the Association of American Colleges, is on computer literacy.[24] It presents brief reports from six schools which have developed innovative, collegewide programs that aim to provide all students, and a good part of the faculty, some computer competence within the next few years. The programs, like the schools, are difficult to categorize and no criteria for selection is given. However, all six are private, urban institutions of small to moderate size. Two are mainly technical (Carnegie-Mellon and Drexel), two are women's colleges (Rollins and Marymount-Manhattan), and two are liberal arts universities (Hamline and Pepperdine).

The reports, written by Forum staff, make no attempt to provide comparable information from each school. It is possible, however, to cull from these reports some trends or tendencies, particularly on such questions previously raised as is programming required, what kinds of applications are emphasized, when and how more computers will be incorporated in the curriculum, as well as whether all students will be required to have them and by when.

Only two of the schools--Drexel and Carnegie-Mellon--have announced their intention to require all students to have a computer. Drexel's program gets underway this fall and Carnegie-Mellon plans to have its system in place by 1986. All but one of the schools seem to require programming as part of their literacy requirement; however, a language is not specified in the reports. The schools anticipate that by 1985 or 1986 all of their graduates will meet their computer requirements. Marymount-Manhattan is an exception to both these

generalizations--it does not have a programming requirement nor does it anticipate that all students will be literate by a certain date. But as a school serving mainly adult women returning to complete a degree, its anticipating that 50 percent of its graduates will be "literate" by 1984 is commendable.

Few of these programs seem to have been started by faculty initiative; rather, they were instituted by administrators who then set up a faculty advisory committee. This provides an interesting contrast to the way in which el/hi systems have started literacy programs. There, the successful mode has been parents approaching the school board and insisting upon a computer education program. According to a consultant who has advised school systems around the country, principals who tried to establish a computer program by administrative decree were "knifed in the back" by teachers hostile to the idea.

No doubt the reason for this is that few faculty members see much mileage in working to get a computer project underway. Pepperdine, which has established a program that emphasizes faculty development, is encouraging them to take advantage of the computing seminars offered by considering computer activities during promotion and tenure evaluations, a recommendation that came from an ad hoc committee appointed by the president.

Literacy for Faculty

The Forum issue also presents briefer reports on exemplary aspects of eleven other schools' computer programs. Almost all of both sets of reports include some comment about faculty literacy. A feature of many schools' programs is workshops or seminars for faculty; most are intensive all-day affairs, which have run for a few consecutive days during the summer. Less successful are one-night-per-week programs.

One of the more elaborate such offerings, one which incorporates the elements of many others, was that sponsored by Indiana University for its own

faculty in early 1983. Called "Teaching and Computers," the conference was held to encourage faculty to develop courseware and to incorporate computer-based learning into their courses. It attracted 500 of the university's 2300 faculty members. Sessions were held on enhancing students' productivity with computers, academic computing services, instructional computing in higher education, and also featured an interactive auction mart from PLATO. The university's computing center also sponsors an on-going computer training program for faculty, which they are working to make into an interactive package.

Computer Literacy Courses

Nine of the seventeen reports in the Forum survey include a definition of computer literacy. Although these are unlikely to be a school's official position on the subject, they offer a representative sample of what people charged with a computer literacy program think the term means:

> [Is] comfortable with the computer as a tool, knows when it is appropriate to use, and understands its capabilities (Rollins).
>
> Understanding the uses of the computer, the capabilities and limitations of the computer, and the ability of the learner to utilize computer instruction and data analysis packages (Marymount-Manhattan).
>
> The ability to use a computer and to communicate with computer and data processing personnel concerning their use of computers; knowledge of the limitations and capabilities of computers and their social, vocational, and educational applications; and ability to demonstrate how to write a simple computer program for the solution of some intellectual problem using a programing language such as BASIC (Hamline).
>
> Recognizing the use of the computer as a tool in a wide variety of disciplines [and] simply being able to interact with a machine (Allegheny).
>
> Learn how to set and solve some interesting problems, code them in a computer language, and run them on the computer (UC, Santa Barbara).
>
> A "minimalist position": people should be able to communicate with computer specialists and know what they are talking about and what can be done on the computer (Colgate).
>
> The realization of the use of computers in today's society, how [we] fit into this scheme, and how [we] might use computers to become productive citizens (George Mason).

> Being literate means primarily having an understanding of the equipment that allows one to be flexible enough to adapt to technical change (Rutgers).*
>
> An understanding of what computers can do and how they can increase productivity in specific fields (University of Washington).*

There are interesting tendencies in these definitions, aspects that recur, which can be organized into four categories:

--Learning about the capabilities of the computer (six mentions)
--Using the computer as a tool (five mentions)
--Learning to program (three mentions)
--Being able to communicate with a computer scientist (two mentions)

Two of these--using the computer as a tool and learning to program--have been discussed before as typical aspects of computer literacy programs found in elementary and high schools. The two others are, appropriately, perhaps more applicable to higher and adult education. A ten year old does not know enough about the world to find lectures on the computer's capabilities very useful, nor is he likely to have to communicate with a computer scientist. This aspect of computer literacy--which was also mentioned by the Carnegie-Mellon professor quoted on page 4--is particularly useful for higher and adult education. If ordinary people are not to feel threatened by computers, enough knowledge of their capabilities to communicate with an expert is essential. We are less likely to fear the computer's potential power if we understand enough about how it operates to tell, as the Carnegie-Mellon prof suggests, some data processor to please clear up one's account or a subordinate that reports are to be done in such a way, and that it is his job to figure out how to tell the computer to do it. Part of computer literacy, then, is little different than being able to deal intelligently with a well-trained auto mechanic.

Syllabi from two computer literacy courses offered by Chicago colleges illustrate another possible trend. One of the courses has been given as a

*These are both quotations from the writer of the Forum article, not from the school.

general studies distribution requirement for three or four years, at a school with one of the strongest computer science programs in town; the other, offered by a smaller school which has just started a computer program out of the math department, will begin in September 1983.

Both courses include programming and require assignments written in BASIC. The newer course covers historical development and applications; the older course concentrates on the computer's innards rather than its social aspects. Perhaps after a few years of offering such a course, a school decides that what students need to understand is how a computer functions rather than how it might affect society, some knowledge of which one can readily acquire through newspapers and magazines.

Computer-Supported Learning

Literacy courses are not the only means by which today's college students learn about computers. As a computer center director quoted in the Forum report said: "Computing literacy is only really attainable if you have continued dealing with the computer.... It's not done by taking one course."[25] This argument can serve as one of many for incorporating computer use into courses across the curriculum. Others are its efficiency, its ability to teach decision-making and problem-solving, its potential for self-paced courses, and the possibility that it can offer instruction otherwise unmanageable or prohibitively expensive. Some numeric manipulations and laboratory simulations--"controllable worlds" to use Alfred Bork's term--are examples of these.

The Forum reports include mention of computer use outside of computer science departments, some that use available programs, and others developed by local faculty. Interestingly, a good portion of these are in English departments--not only for text editing or writing skills, but for literary analysis. One professor, for instance, has encoded The Canterbury Tales for a text

analysis of Chaucer. Music and art departments include computer use for graphics and to help students learn to identify melodic intervals using a synthesizer board.

Sociology, psychology, and economics departments use computers for statistical analysis, survey research, and studying demographic changes. Science departments mentioned a fly-breeding simulation for a genetics course and a geological simulation to determine where to dig an oil well.

Some Implications

Uses such as these will continue to proliferate, particularly as students who acquired their computer literacy in high school come to predominate college classes. At the EDUCOM conference in 1981, Arthur Luehrmann discussed these implications of el/hi programs, predicting that by fall 1984 most college entrants will have had at least one computer course, an estimate that has proven to be overly optimistic. His five-year prediction--for fall 1986--may well be less so with the continuing rapid growth of literacy programs in high schools. Luehrmann saw the high school class of 1986 as having had one or two computer languages, structured programming, algorithms, and data structures, and that these students would be experienced with word processing. Further, these students' computer experience will be with micros rather than the mainframes that still dominate college instruction.

Luehrmann also said that the big problem for higher education will be determining the students' level of knowledge, and that colleges would probably have to offer a variety of computer courses for freshmen: "bonehead" computing for those who missed it in high school, "orthodonture," filling in the gaps left by high school instruction, and an honors course for those who will have passed the advanced placement test.

Another report on the state of college computing today is provided by a

survey of college entrance requirements for computing conducted last spring at New Trier High School. Charles Schultz, a member of the math department there, polled the 50 colleges most often applied to by New Trier's class of 1982.[27] Questionnaires were sent to six departments at these schools, and at least one response was received from three-fourths of the institutions queried.

The most badly needed skill, according to the survey, is an ability to type, and the schools also reported a need for stronger reading, writing, and math skills. The colleges were not interested in courses on history or social implications of computing, or in COBOL, LOGO, or assembly language programming.

What the colleges did want the students to know was something of computer system components and logic, the ability to write flow charts and program in BASIC, FORTRAN, or Pascal. The colleges did not foresee that they would have a computer requirement for admission. A survey of at least equal interest, and one that will probably be done at many colleges over the next few years, will be to poll the freshman class to determine what they have already learned about computing, and what additional knowledge they expect to acquire as undergraduates.

A COMPUTER LITERATE SOCIETY

Computer literacy, then, does have some rather specific components. For individuals, whether students or business executives, it involves knowing how to use a computer as a tool. This ought not to be abstract knowledge, but hands-on experience using a computer to simplify or more efficiently handle tasks one must accomplish on a regular basis. Computer literate students will use micros instructionally, to more readily absorb information or to learn through juxtaposing conflicting data, with the computer's interactivity forcing them to make discoveries passive forms of instruction do not.

For their teachers, computer literacy may mean managing instruction more efficiently--keeping records, grading tests and recording scores--and word

processing for paperwork at home and at school. Faculty, like other professionals and executives, can use their computer literateness to process and record information, access databases, write papers, keep accounts. Adults whose jobs do not require these tasks can become computer literate, if they so choose, for artistic expression or to satisfy intellectual curiosity.

Computer literacy probably will decreasingly involve programming. The chief virtues of learning to program--that it gives one an ability to control the computer and that it teaches disciplined habits of mind--are becoming less applicable due to the growing availability of menu-driven packages. Learning to use many of these creatively requires gaining some disciplined control over the computer and, unless one learns to program in machine language, one is highly dependent on the operating system and thus does not really learn to control the computer in any real sense. If disciplined habits of mind are again to be stressed as an aspect of schooling, perhaps Latin and calculus rather than programming should be more generally required.

Knowing the computer's capabilities, the third most frequently mentioned aspect of literacy, is an umbrella term which can cover the "soft" side of computer science--social impact, etc.--and more "hard" knowledge such as acquiring a mental model of how information is processed and stored electronically. A computer literate society is one composed of people knowledgeable enough about computers to make intelligent public policy decisions about their use, people sufficiently confident about this knowledge to not be intimidated by experts or data processors who contend that a malfunction is the computer's fault rather than a people problem.

In sum, computer literacy seems to have three components: the ability to use a computer as a tool, the ability to manipulate a computer beyond that of the casual end-user--an ability that can be acquired either by learning to use an applications package or actually learning to program--and enough knowledge

of the computer's capabilities to make intelligent decisions regarding its social and political use.

As a society, we are asking that children acquire the rudiments of this new literacy through the school. But for adults, such a requirement is most often taken on voluntarily. A question public policy may soon face is whether or not this is sufficient for the social challenge posed by computer technology. Carolyn Marvin's article on computer ease addresses this question as well. For an historical precedent, she cites a study of medieval England, which describes attempts by successive royal governments to establish a uniform standard of written literacy for administrative purposes.[28] At the beginning of this process, there was

> The existence side by side of sacred, bureaucratic, and vernacular literacies involving different languages and performing different functions.
>
> Not only were there several distinct written literacies, but many familiar devices of literacy, such as alphabetizing, indexing, procedures for dating documents, and conventions for validating their authenticity were just being invented and developed.[29]

The parallel to the present profusion of computer languages and machines that cannot communicate with each other is obvious. Alluding to this, Marvin says:

> Just as official intervention was necessary to educate a substantial part of the population in the new cognitive habits of written literacy, there are good reasons to expect that a similar scale of effort will be needed to achieve the popular diffusion of computer literacy.[30]

Compatible machines and languages are not the only complication faced by a society wanting to institutionalize computer literacy. There is presently a class--and race--differential in computer literacy. Marvin also raises this question succinctly:

> It is still the case that the faculty child will be more likely than the ghetto child to find a way into the computer center of the university where both their parents work.[31]

Although poor schools are catching up with rich schools in numbers of computers, a difference has developed between the computing experience children

in affluent school districts have and that of children at impoverished schools. The former learn programming, while the latter are offered computer-assisted instruction. As Dan Levin describes this difference:

> *Affluent students are learning to tell the computer what to do,* and poorer students are doing what the computer tells them to do.[32]

This class difference applies to adults as well. Purchasing a computer is a major investment. Despite their rapidly falling prices, any kind of computer is still affordable only by the more comfortable members of the middle class, those who have the background and the leisure, as well as the money, to learn to use it. Marvin poses the problem thus:

> For a long time the maintenance of social cohesion has required that citizens be able with facility to send messages to and receive messages from those they do not know and who are not present.... If, indeed, the comparison between computer literacy and written literacy is a valid one, and if computer literacy is likely to become as important a device for creating, maintaining, and reproducing collective life as written literacy is now, we may have to consider whether there is also a public obligation to train citizens in this newest technique of public life.[33]

Once there is some general agreement as to what computer literacy is, as a society we can face the issue of whether or not it should be required of citizens.

NOTES

1. Carolyn Marvin and Mark Winthur, "Computer-Ease: A Twentieth-Century Literacy Emergent," Journal of Communications, Winter 1983, pp. 92-106.

2. Ibid., p. 92.

3. This discussion is adapted from Helen Aron, "The Impact of Computers on Literacy," Lifelong Learning, December 1982, pp. 8-9. Her terms are quoted here.

4. Marvin & Winthur, p. 4.

5. David Moursund, "The Computer-Literate Student," Proceedings from The Computer: Extension of the Human Mind, July 1982, College of Education, University of Oregon, Eugene, pp. 3-11 (ERIC no. ED 219 860).

6. Ibid., p. 4.

7. Quoted in Dan Levin, "Everybody Wants 'Computer Literacy,' So Maybe We Should Know What It Means," American School Board Journal, March 1983, p. 25.

8. Ibid.

9. Beverly Hunter, Human Resources Research Organization, Alexandria, VA, quoted in Levin, ibid.

10. Arthur Luehrmann and Herbert Peckham, Computer Literacy: A Hands-On Approach (New York: McGraw-Hill, 1983).

11. Alfred Bork, "The Fourth Revolution--Computers and Learning," Proceedings from The Computer: Extension of the Human Mind, pp. 12-28. (For complete reference, see note 5.)

12. Quoted in ibid., p. 23.

13. Levin, p. 25.

14. Ibid., p. 26.

15. Ibid.

16. Ibid., p. 27.

17. Ibid.

18. "How to Conquer Fear of Computers," Business Week, March 29, 1982, pp. 176-78.

19. "Finding A on the Keyboard," Time, May 16, 1983, p. 64.

20. Samuel Spero and Jon Jones, "Computer Literacy for Educational Administrators," Proceedings from The Tomorrow in New Technology, 1982, Association for Educational Data Systems, Washington, D.C., pp. 292-95 (ERIC no. ED 223 239).

21. Roger Hiemstra and Hugh Tucker, "Personal Computer Literacy: Personal and Professional Applications," Paper presented at the National Adult Education Conference, November 13, 1982, San Antonio, TX (ERIC no. ED 223 815).

22. Michael W. Robbins, "Education for the Eighties," New York, August 23, 1983, pp. 38-41.

23. Technology and Education: Policy, Implementation, Evaluation, Proceedings of the National Conference on Technology and Education, January 26-28, 1981, Institute for Educational Leadership, Washington, D.C. (ERIC no. ED 220 916).

24. Forum for Liberal Education, May/June 1983.

25. Ibid., p. 16.

26. Arthur Luehrmann, "Computer Literacy," Selected Papers of the EDUCOM Annual Conference, October 1981, Interuniversity Communications Council, Kansas City, MO, pp. 3-5 (ERIC no. ED 222 165).

27. Charles E. Schultz, "A Survey of Fifty Colleges and Universities Regarding Entrance and Graduation Requirements," Proceedings from The Role of the Computer in Education, April 1983, Micro-Ideas, Glenview, IL, pp. 124-33.

28. This study was published as Michael Clanchy, From Memory to Written Record: England 1066-1307, Cambridge, MA: Harvard University Press, 1979.

29. Marvin & Winthur, p. 94.

30. Ibid., p. 95.

31. Ibid., p. 104.

32. Levin, p. 27.

33. Marvin & Winthur, pp. 93-94.